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ALUMINUM ORES OF THE USSR

Bauxites

The principal bauxite deposits of the USSR are located in two areas -- in the Tikhvin area of Leningrad Oblast and in the Urals.

The Tikhvin bauxite deposits were discovered in 1916. Their formation goes back to the Carboniferous period. Tikhvin bauxites occupy a narrow strip, 6 - 12 kilometers wide. They generally occur in irregularly shaped pockets (seams) and are covered with sandstone and clay of glacial origin. The outer appearance of the Tikhvin bauxites is most diversified. The color of the ores runs through all shades from white to red and violet. Their specific gravity and chemical composition are just as inconstant.

The chemical composition of Tikhvin bauxites varies within the following limits: a rock form in which the relation between alumina and silica corresponds to clay, and ore in which the amount of alumina reaches 70 percent while the SiO_2 is down to 2 - 2.5 percent. The quantity of chemically combined water in the main bauxite mass lies within the range of 12 - 14 percent, but there are bauxites which contain up to 20 percent H_2O. TiO_2 generally does not exceed 2.5 - 3.0 percent. The amount of Fe_2O_3 varies greatly -- from 3 - 5 percent in white bauxite to 30 percent in bauxites with a high iron content (generally powdery). Several varieties of Tikhvin bauxites contain CaO and also chrome up to 0.2 percent.

The average chemical composition of the Tikhvin bauxites is as follows:

47.7% Al_2O_3, 17.2% Fe_2O_3, 13.2% SiO_2, 2.6% TiO_2, 3.9% CaO, and 15.4% H_2O.

Aluminum hydroxide is found in the ore principally in the form of boehmite and in lesser amount as hydrargillite. In addition to ferric oxide and silica, the most important components of Tikhvin bauxites are kaolinite and calcite. Titanium oxide occurs in the form of fine crystals of rutile.

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The high silica content of the Tikhvin bauxites reduces their quality as aluminum ore.

Important bauxite deposits are located in the Northern Urals in the district of Serov, in the Central Urals in the district of Kamensk, and in the Southern Urals in the Bashkir ASSR.

Northern Ural bauxites discovered in 1931 comprise a number of deposits, the most important of which are Krasnaya Shapochka, Bogoslovsk, and Ivdel'sk. Northern Ural bauxites, the formation of which goes back to the Paleozoic period, occur in limestone and their main mass represents a solid rock of brownish-red color and oolitic structure. Of less frequent occurrence is a variety of bauxites having a platy structure and externally resembling jasper.

The stratified character of the deposits and the occurrence of coral skeletons have led Academician A. D. Arkhangel'skiy to the conclusion that the bauxites of the Northern Urals originated as a result of the chemical precipation of hydrates from the water solution of salt to the bottom of an ancient sea. Owing to the higher content of Al_2O_3 and the small admixture of SiO_2, these bauxites are equal in quality to the better grades of French bauxites.

Of especially good quality are the bauxites of the Krasnaya Shapochka deposit. The chemical composition of the bauxite of this deposit is as follows:

56% Al_2O_3; 25% Fe_2O_3; 3.5% SiO_2; 2.2% TiO_2, and 11% H_2O.

Mineralogically, the bauxites of the Northern Urals represent rocks of the diasporeboehmite type. Iron occurs in them principally in the form of anhydrous hematite Fe_2O_3. Silica is found partially in a free state as quartz and gel (opal), and partially in combined form, as chamoisite ($3\,H_2O.3FeO.3Al_2O_3 \cdot 2SiO_2$). Finally, titanium is found as crystallized rutile, and also in the form of gel.

According to the geologist, N. A. Arkhangel'skiy, the mineralogical composition of Krasnaya Shapochka bauxites may be presented as follows (in percent):

Diaspore and boehmite AlOOH	62.4
Hematite Fe_2O_3	20.7
Chamosisite $3H_2O$. 3FeO . 3 Al_2O_3 and mica	10.4
Kaolinite $Al_2O_3 \cdot 2SiO_2 \cdot 2H_2O$	0.8
Carbonates of calcium and magnesium	1.7
Other components (pyrite, titanic mineral, phosphorus, etc.)	4.0
	100.0

Bauxites of the Krasnaya Shapochka deposit occur in the form of a sloping layer with an incline of 25 - 30 degrees. The ore body consists of massive rocks requiring blasting when they are mined.

Several bauxite deposits are known to be located in the Middle Urals. The best explored of those deposits is the Sokolovsk (Kamensk Rayon), which was discovered and prospected in 1932 - 1933. The deposit is a plate-like, almost horizontal bed, covered by an alluvial layer up to 5 meters thick. The formation of the Sokolovsk bauxites goes back to the Mesozoic period. Depending on the content of SiO_2, Sokolovsk bauxites can be divided into two varieties which are more or less tightly mixed in the ore stratum: rocky bauxites containing up to 3.7 percent silica, and earthy (mellow) bauxites, up to 9 percent silica. The average chemical composition of the Sokolovsk bauxites is as follows:

31.7% Al_2O_3; 38.3% Fe_2O_3; 5.8% SiO_2; 4.5% TiO_2; and 18 - 19% H_2O.

The mineralogical composition of the Sokolovsk bauxites according to N. A. Arkhangel'skiy, can be described as follows(in percent):

Hydrargillite $Al(OH)_3$	5.9
Hematite Fe_2O_3	29.9
Kaolinite $Al_2O_3.2H_2O.\ 2SiO_2$	7.1
Opal SiO_2 (gel)	0.6
Quartz SiO_2 (crystallized)	5.1
Other components (pyrite, rutile, phosphorus, etc.)	5.7
	100.0

The fact that alumina appear in the Sokolovsk bauxites in the form of hydrargillite, constitutes a favorable factor, since the latter is more chemically active than diaspore or boehmite. This circumstance facilitates the extraction of alumina from bauxites. However, the relatively low content of Al_2O_3 and high content of SiO_2 make these bauxites less valuable than those of the Northern Urals.

The bauxite deposits in the Southern Urals were discovered in October 1935. They have the shape of a plate-like bed spread in limestones. Red platy, lumpy jasper-like bauxites are found most frequently.

Mineralogically, the Southern Ural bauxites belong to the boehmite (Ivanov Log) and diaspore (Kuksnik) type. Their chemical composition is more or less uniform as follows:

53 - 57% Al_2O_3; 18 - 23% Fe_2O_3; 5 - 7% SiO_2, and 11 - 13% H_2O

In the upper bed of the stratum, white bauxite is sometimes found containing 78 percent of Al_2O_3, but only 0.4 percent of SiO_2.

The Southern Ural bauxites must be considered a first-class raw material base of the USSR aluminum industry.

Nephelines

Nepheline $(Na.K)_2O.\ Al_2O_3.2SiO_2$ enters into the composition of apatite-nephiline rock of the Kola peninsula in the Khibinsk massif between the southern branches of the Kukisvumchorr. (Discovered in 1921 by an expedition of the Institute for the Study of the North, Academy of Sciences USSR).

Apatite-nepheline rock, beside the two principal components apatite $(Ca_3(PO_4)_2)$ and nepheline, also contains small amounts of titanomagnetite and hornblende. The average content of apatite is about 70 percent, and of nepheline, 20 - 25 percent.

For conversion into phosphorous fertilizers (superphosphate), apatite-nepheline rock, is subjected to flotation concentration, the aim being the recovery of the apatite. At the same time, the tails contain a rich concentration of nepheline (about 95 percent).

The average chemical composition of the nepheline fraction is as follows (in percent):

Al_2O_3	20 - 30
SiO_2	43 - 44
Fe_2O_3	3 - 4
CaO	2 - 3
Na_2O K_2O	20

A high nepheline content is also met in the mineral rock called urtite. Urtite contains up to 90 percent nepheline and 27 - 28 percent Al_2O_3. The enormous reserves of nepheline rock, the constancy of the chemical composition of nephilite fractions, and the presence in them of other useful constituents (K_2O+Na_2O) besides Al_2O_3, make nepheline a valuable raw material for the USSR aluminum industry.

Alunites

Alunite ores are of real interest to the aluminum industry. Because they contain aluminum oxides, sulfuric anhydride and alkalies, treatment of alunites with the aim of separating all useful components is possible.

Mineralogically, alunite is a basic sulfate of aluminum and potassium ($K_2SO_4 \cdot Al_2(SO_4)_3 \cdot 2Al(OH)_6$), although sodium may also be present. Alunites are formed by the action of natural sulfuric acid solutions on silicates.

The largest deposit of alunite rock in the USSR is the Zaglikskiy, located in the Azerbaydzhan SSR on the summit of the Sharu-Kar Mountain (Acid Stone). Zaglikskiy alunites have the following chemical composition (in percent):

Al_2O_3	20 - 21	Na_2O+K_2O	4.5 - 5
SiO_2	41 - 42	SO_2	22 - 23
Fe_2O_3	4 - 5	H_2O	6 - 7

The silica in Zaglikskiy alunites is primarily in the form of quartz.

A number of other large alunite deposits have recently been discovered and prospected in the USSR. Of these, the Aktashsk in the Kazak SSR and the Chusayak in Uzbek SSR are the most important.

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